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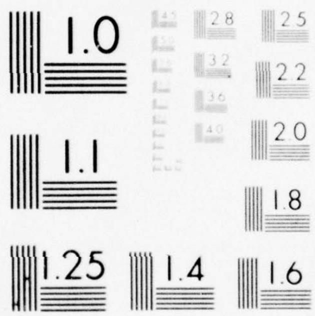

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NEW CONCEPTS FOR PROVISIONING PARAMETER ESTIMATES: PART II: TASK DISTRIBUTIONS AND WASHOUT RATES

US ARMY
DARCOM

DRC
INVENTORY
RESEARCH
OFFICE

December 1976

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NEW CONCEPTS FOR PROVISIONING PARAMETER ESTIMATES:
PART II: TASK DISTRIBUTIONS & WASHOUT RATES

TECHNICAL REPORT

BY

DONALD A. ORR

DECEMBER 1976

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
6 4. TITLE (and Subtitle) NEW CONCEPTS FOR PROVISIONING PARAMETER ESTIMATES. PART II. TASK DISTRIBUTIONS & WASHOUT RATES. and		9 5. TYPE OF REPORT & PERIOD COVERED Technical Report.
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) 10 Donald A. Orr		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS DRC Inventory Research Office, ALMC Room 800 - US Custom House 2nd & Chestnut Sts., Phila., Pa. 19106		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Materiel Development & Readiness Command 5001 Eisenhower Avenue Alexandria, Virginia 22333		11 12. REPORT DATE Dec[redacted] 1976
		13. NUMBER OF PAGES 26
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) 14 IRO-TR-77-4 12 31p.		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Washout rates
Maintenance Task Distributions
Replacement Task Distributions
Provisioning
Reparables

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Several promising approaches of initially estimating maintenance (MTD) and replacement task distributions (RTD), and washout (condemnation) rates are discussed. Values of these parameters are important in the determination of initial provisioning quantities at different echelons of support.

An inductive procedure is outlined for estimating MTD's and RTD's of components using a system block analysis.

A separate study is recommended to pursue and develop the methods for cont

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Block 20 - Abstract

estimating washout rates of reparable components.
A summary of current practices is included.

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CHAPTER I

INTRODUCTION

In determining the quantity of a part to be initially provided to a support level (supply and maintenance), there are five or six important provisioning parameters, the values of which have to be initially estimated before deployment of the end item/system and before consumption experience is obtained: maintenance factors, replacement task distributions, maintenance task distributions and condemnation rates for reparables and turn around times (both supply and repair). In this report and [2], I shall treat the estimation of each parameter for the most part independently, but I should like to indicate in this section how these parameters for a part are inextricably entwined with each other as well as with those of other components, sub- and supra- included. This section should engender caution not futility.

When a part of a system fails, sometimes it is replaced; sometimes it is replaced when it does not fail and something else does; sometimes when nothing fails. The maintenance factor indicates this replacement rate. What percentage of these replacements should be done at organization, DSU, GSU and Depot support levels? It depends upon the resources (men, parts, test equipment) at each level. But the costing of various resource allocation schemes and subsequent replacement policies depend upon the replacement rates and probabilities of different modes of failures. The frequency of replacement of a part at a given support level also depends upon the frequency with which a reparable next high assembly is repaired (and may need this part replaced) at this level. In turn, this level of repair analysis is also a resource allocation problem, combined with a repair versus throwaway decision; and <u>this</u> problem depends upon failure and replacement probabilities of the parts within the reparable assembly. The level of repair analysis will render <u>prescriptive</u>* maintenance task distributions and condemnation rates - maybe; these values depend upon the MTD's of higher indenture levels. Also <u>predictive</u>** MTD's

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* How things should occur.

** How things would occur

and condemnation rates depend greatly on the surplus or deficit of spares and parts at various levels (if a part is not available, the assembly may be sent to another level) and on human error and caprice. The times to repair and to order a necessary part at various support levels also impact on the where to repair and where to replace decisions. Conversely the time to obtain a part from a higher level may be long if the part is not there due to other poor provisioning parameter estimates, and time to repair can be longer due to poor estimates of facility requirements.

Logistics support analysis attempts to cover all these system support problems in the organized manner, but many of the interactions are not or cannot be considered. Maintenance support models and simulations are useful tools for evaluating alternatives but suffer the need for a great number of inputs, the values of many (particularly costs) being questionable. And in essence, the task distributions, failure rates, and turn-around times in these simulation models don't reflect all the field maintenance problems and over-usage, under-usage and misusage of the end items.

This report shall discuss some innovative techniques for estimating task distributions and condemnation - washout rates. Turn-around times are not discussed, since we have nothing new to say at this time. Suggestions for improving the maintenance factor estimates are presented in Orr [2]. In the current report I try to concentrate on the three concepts presented in the last mentioned report - system block analysis for initial estimates, family measures of central tendency for groups of parts, and methods of updating estimates with practical sources of data - for the two task distributions and washout rates. Since the values of these three parameters depend greatly on the particular maintenance support environment, the usefulness of the block and family approaches is somewhat diluted. For the most part the "new" approaches are only outlined and are intended to stimulate more thought along certain avenues and to point out blind alleys and high toll roads.

First, current practices are reviewed.

Summary of Current Practices

DARCOM Headquarters, DRCMM-MP distributed questionnaires designed by IRO to the six Commodity Commands. Ten respondents from each command familiar with their current provisioning parameter estimation practices completed the questionnaires. Tables 1.2, 1.3, 1.4 summarize the consensus opinions on various aspects of the methodologies for washout rates, maintenance task distributions, and repair cycle times; summaries of the responses on maintenance factors are presented in another IRO report [2].

A general statement (with exceptions) that might be made for all three parameters is that the initial estimates are engineering judgements of provisioners - with and without back up data - and that any updating is not part of a formal procedure in most cases. Ironically most respondents felt the initial estimates were adequate or good (probably meaning as good as could be expected under the circumstances).

TABLE 1.1

Code	Parameter: Maintenance Task Distribution, Washout Rate or Repair Times
	Subject: Initial Estimate/Event
1	Estimate procured from contractor as part of the Provisioning Technical Documentation (MIL-STD 1552) <u>with</u> supporting test data or other empirical data to backup the estimate.
2	Estimate procured from contractor as part of the Provisioning Technical Documentation (MIL-STD 1552) <u>without</u> supporting data to backup the estimate.
3	Estimate procured as described under Event 1 and then modified by technicians of the Army Provisioning Activity.
4	Estimate procured as described under Event 2 and then modified by technicians of the Army Provisioning Activity.
5	Estimate furnished by technicians of the Army Provisioning Activity, based on engineering judgement and backed-up by documented test or other empirical data.
6	Estimate furnished as described under Event 5 except without documented backup data.
7	Estimate derived through application of practices other than those described in Events 1 through 9. (Please provide explanation on reverse side)

TABLE 1.1 (cont)

Code	Parameter: Maintenance Task Distribution, Washout Rate or Repair Times
	Subject: Updating Practices/Event
	(Note: The term "data" used below refers to recorded, quantitative information required to update the initial estimate at the National Maintenance Point level (NMP))
8	Data is obtained through a Sample Data Collection (SDC) Plan (Ref. TM 38-750)
9	Data is obtained through routine feedback of records independent of or supplemental to SDC activities.
10	Formal procedure applicable to local NMP is used to update initial estimate with actual experience data.
11	Initial estimate is updated with actual experience data without application of a formal procedure.
12	Data suitable for updating is not obtained.
13	Previous estimates documented in Selection Worksheets or equivalent data files (e.g., PMDR) are periodically revised to reflect updated values.

CONSENSUS OPINIONS	AVSCOM	MICOM	ARMCOM	TACOM	ECOM	TROSCOM
I MOST UTILIZED METHOD OF OBTAINING INITIAL ESTIMATES.	6	1,2	6	5,7	6	6
II MOST UTILIZED METHOD OF UPDATING INITIAL ESTIMATES.	10,13	13	11,12	12	12	11
III AVERAGE QUALITY OF INITIAL ESTIMATE.	Adequate	Good	Adequate	Good	Adequate	Adequate
IV BIAS OF INITIAL ESTIMATE	None	Slightly High	None	High	None	None

TABLE 1.2: CURRENT WASHOUT RATE METHODOLOGY

CONSENSUS OPINIONS	AVSCOM	MICOM	ARMCOM	TACOM	ECOM	TROSCOM
I MOST UTILIZED METHOD OF OBTAINING INITIAL ESTIMATES.	6	1,6	5-6	6	5-6	6
II MOST UTILIZED METHOD OF UPDATING INITIAL ESTIMATES.	12	13	12	8-9	12	11
III AVERAGE QUALITY OF INITIAL ESTIMATE.	Adequate	Good	Poor	Adequate	Adequate	Adequate

TABLE 1.3: CURRENT MAINTENANCE TASK DISTRIBUTION

CONSENSUS OPINIONS	AVSCOM	MICOM	ARMCOM	TACOM	ECOM	TROSCOM
I MOST UTILIZED METHOD OF OBTAINING INITIAL ESTIMATES.	None	1,6	5	6	6	7
II MOST UTILIZED METHOD OF UPDATING INITIAL ESTIMATES.	None	13	12	No Consensus	12	11,13
III AVERAGE QUALITY OF INITIAL ESTIMATE.	Adequate	Good	Poor	Good	Adequate	Adequate
IV BIAS OF INITIAL ESTIMATE	None	None	None-but some low	High	None	None

TABLE 1.4: CURRENT REPAIR CYCLE TIME METHODOLOGY

CHAPTER II

MAINTENANCE & REPLACEMENT TASK DISTRIBUTION (MTD, RTD)

2.1 Block Analysis for Initial Estimates

As discussed in Chapter I and as evident in the example below, it it best to estimate MTD's and RTD's together, since the task distribution amongst parts and assemblies in a system configuration are interdependent.

2.1.1 Basic Procedure

The procedure is an inductive top-down analysis of an entire system. Assume one is at the inductive step for analyzing the maintenance on certain assembly. Let CA be a reparable component/assembly contained in a next higher assembly NHA. Let C_i's be components (reparables or consumable parts) in CA.

Make a checklist of the normal steps in maintenance for reparable CA, making decisions based on known maintenance codes and task assignments from previous analysis, and assigning detection probabilities. That is,

i) At the lowest maintenance support level, can one detect which C_i failed without removing CA? Assign a probability.

ii) If a particular C_i failed, can it be replaced at this level?

iii) If "no" to i) and ii), send NHA (or end item) to the level which can remove CA (It could be the same level).

iv) At the appropriate level, after removing CA, can one detect the C_i responsible for failure? Assign a probability.

v) For a particular C_i, can it be replaced at this level? If not, send CA to the level for replacing C_i.

vi) If "no" to iv), send CA to level with complete repair.

Steps i) to vi) are to be done for each component. When the level at which CA repair is done depends on which C_i fails, determine the relative probability of C_i failing and the conditional probability of repair at a

level given that C_i fails.

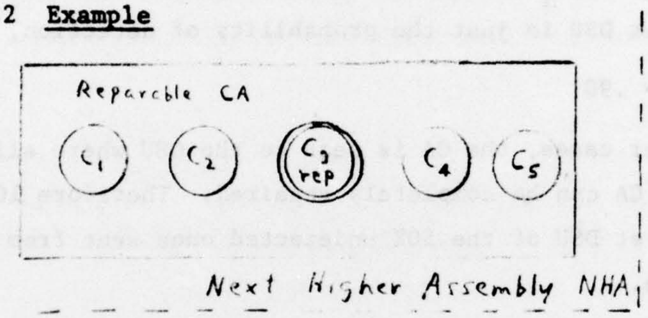
The fundamental steps in the inductive analysis are:

a. From the probability values in the steps above, from the maintenance codes, and from the RTD of CA obtained from higher level analysis, determine the MTD of CA and the RTDS's of the $C_i$is.

b. For any C_i that is a reparable, repeat the process. Thus if C_i is a reparable, use the RTD of C_i along with other inputs to obtain the RTD's of parts in C_i and the MTD of C_i.

c. Initialization of analysis - the MTD of the end item/system is determined by probability of failures of major sub-systems and where, upon failure, they are probably repaired.

2.1.2 <u>Example</u>



In diagram C_1, C_2, C_4, C_5 can be replaced at ORG support level (field organizational unit)

Reparable C_3 can be replaced at DSU

CA can be replaced at DSU

CA can be completely repaired at GSU

1. Let Probability (detecting at ORG the failure of C_i) = .50.

2. Therefore, the replacement fraction rf at ORG of the RTD of components C_1, C_2, C_4, C_5 is given by:

$$rf_{ORG}(1) = rf_{ORG}(2) = rf_{ORG}(4) = rf_{ORG}(5) = .50$$

3. With probability of .50 (approximately), undetected failures necessitate CA being removed at DSU.

4. Let Probability (upon removal of CA, detecting at DSU the failure of C_i) = .90.

5. Since 50% of the time, the component failures in CA have not yet been detected when CA arrives and is removed at DSU, and since 90% of these are then detected, the replacement fractions rf at DSU are given by:

$$rf_{DSU}(1) = rf_{DSU}(2) = rf_{DSU}(4) = rf_{DSU}(5) = .50 \times .90 = .45$$

Since for C_3, any failures detected at ORG (50% of time) are nevertheless replaced at DSU,

$$rf_{DSU}(3) = .50 + .50 \times .90 = .95$$

Since all the components C_i of concern can be replaced at DSU, the repair fraction Rf for CA at DSU is just the probability of detection, i.e.

$$Rf_{DSU}(CA) = .90$$

6. In all other cases, the CA is sent to the GSU where all failures can be detected and CA can be completely repaired. Therefore 10% of the undetected failures at DSU of the 50% undetected ones sent from ORG are replaced at GSU, i.e.

$$rf_{GSU}(i) = .10 \times .50 = .05 \ , \ i = 1,2,3,4,5$$

and naturally the repair fraction for CA is 10%, i.e.

$$Rf_{GSU}(CA) = .10$$

7. Combining the results we obtain "unadjusted" task distribution percentages as follows:*

	ORG	DSU	GSU
RTD (for C_1, C_2, C_4, C_5)	.50	.45	.05
RTD (C_3)		.95	.05
MTD (CA)		.90	.10

However, the values in steps 4., 5., 6. are for an assumed replacement fraction of CA at DSU = 1.00. If from higher level analysis of

* Note that even though components are being replaced at ORG to "repair" the CA, the CA itself is not removed and a spare is not required at ORG; hence the effective MTD(CA) (in terms of determining pipeline spares) is non-zero at the DSU and above.

replacement actions one knows that

$$rf_{DSU}(CA) = .8 \text{ and } rf_{GSU}(CA) = .2$$

then 20% of the values in the DSU column of the above table are shifted to the GSU level, since only 80% of the times is the CA removed and worked upon at the DSU. Adjusted percentages are:

	ORG	DSU	GSU
RTD (for C_1, C_2, C_4, C_5)	.50	.45 x .8 = .36	.14
RTD (C_3)		.95 x .8 = .76	.24
MTD (CA)		.72	.28

Subsequently any analysis for the task distributions of the subcomponents of reparable C_3 will have to be adjusted for the percentage breakout (.76, .24).

2.1.3 Problems and Issues

In the preceding approach, the degree of refinement deemed worthwhile is completely up to the analyst for a particular system. The report of a study of MTD's (and turn-around times) by the Maintenance Support Center [1] covers most of the issues in formulating the MTD problem. Although their methodology can be improved, they recognize that MTD's should be part of maintenance task analysis and should vary by theatre. Keeping in mind that it is foolish to be too sophisticated while many of the inputs are uncertain, one may consider the following refinements. They are listed in some order of importance.

a. The washout rate of reparables was not covered in the example. It should be straightforward to adjust the MTD and RTD percentages to account for a washout percentage.

b. Adjustments for planned or unplanned overflow - this shifts MTD (and to a lesser degree, RTD) towards higher support levels. It could be some flat %, e.g. 10% of ORG percentage is shifted to DSU. Then 10% of DSU percentage is shifted to GSU, etc.

c. Scheduled replacements - these are deterministic and usually planned to be done at a certain level.

Example

	ORG	DSU	GSU	
RTD (random)	50	36	14	replacements
RTD (scheduled)	100			"
RTD (final)	75%	18%	7%	

d. Probability of detection - this could vary by components C_i but this seemingly becomes too complex*. However, the probability of detection should increase with support levels, as in the example.

e. The interplay between the impact of component RTD on CA RTD (bottom up analysis) and impact of NHA RTD on CA RTD (top-down analysis) could be infinitely regressed, but this approach is not amenable to analysis.

2.2 Family Concept for Initial Estimates

The idea is to group parts and assemblies which may have similar RTD's (similarly for similar MTD's). Any reasonable thought on how maintenance is done or should be done will reject this idea. Maintenance task analysis is by system and has little or no basis on past percentages for the components considered separately. Moreover, the maintenance environment varies by system and theatre.

2.3 Updating of Initial Estimates

The task percentages can only be updated by observing replacement and repair actions by components by maintenance support level. This detailed data is available on a routine basis only for aircraft systems. Other end items require the DARCOM approval of a sample data collection (SDC) plan to study RAM values in a field environment. Moreover updated MTD's and RTD's are predictive percentages which arise on the particular system from the peculiarities of its maintenance environment; this value may be of

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*However, one may wish to incorporate this sophistication, if the probability of repair at each level depends on which C_i fails.

value in re-provisioning but of less value in rendering <u>prescriptive</u> task distribution percentages for future new systems.

Consequently no plans should be made for updating on a routine basis over all end items.

CHAPTER III

WASHOUT RATES FOR REPARABLES

3.1 Problems and Issues

This chapter summarizes the current extent of exploratory innovative effort on washout (attrition, condemnation) rates of reparable component/ assemblies (CA). Expansion of the idea merits a separate study project. An accurate washout rate (WR) estimate is important; support requirements for high cost reparables are sensitive to errors in WR; an estimate of 4% when the actual WR is 1% is as bad (or worse) as overestimating a maintenance factor by 4 times.

For the three concepts focused upon in this report, the issues are not clear cut. A system block analysis can give only part of the initial WR estimate. A family concept of grouping CA's is straight forward but probably not as promising as its "cousin" concepts - regression and cluster analyses. A practical method of updating WR estimates would be based on observations of condemnations at the depot level, if the depot condemnation rate is representative of the washout rate in general.

There are three basic questions, the answers to which influence a particular washout decision on a CA:

1. Can it be repaired?
2. Should it be repaired?
3. Will it be repaired?

Question No. 1 is mechanistic and depends upon catastrophic failures (fusion of circuits), cumulative disorders thru neglect, accidents (dropping), destroying the assembly thru repair mistakes. Question No. 2 is economic (or should be) and depends upon costs of repair (parts, labor), turn-around times, cost of repair assembly. Question No. 3 is humanistic and depends upon available talent, caprice, organizational SNAFUS, changes in policy, to mention a few. Another related question: if the next higher assembly is washed out, will the CA's within be cannibalized and salvaged?

For reference, I list some factors causing washout, some more likely

than others.

a. Too many components are down. This is unlikely by chance except in cases of linked failures.

b. A component which cannot be removed is beyond repair. With proper design this should be unlikely.

c. Chassis failure. Components should be cannibalized.

d. The down components cost more to replace than the component/assembly. This may be likely for simpler CA's.

e. Repair mistakes.

f. Accidents, catastrophes.

g. Misplacing CA

h. Increase in failure rates; age

i. Unusual failure mode; unidentifiable cause. Unlikely.

j. Labor involved is not worth it.

One can see that there are many factors and situations divorced from system block structure and probabilities of component failures. I will address in Section 3.3 a method of obtaining bounds on washout rates by block analysis if rational thinking is applied to question No. 2.

3.2 Family Concept and Other Statistical Techniques

The washout rate for assemblies should decrease as complexity increases. (One does not throw away a missile system.)* This is due to increased cost of the CA, increased modularization and redundancy, i.e., it is economic to repair the CA. Also, due to localization, there is less impact on the whole assembly/system of repair mistakes or accidents.

One can hypothesize what a curve of WR versus a measure of complexity CPX might look like. Let $\boxed{X|X|X|X}$ symbolically represent a CA comprised entirely of consumables (X) at its next lower indenture level; Let $\boxed{X|X|R|R}$ denote a CA comprised partly of consumables and reparables (R); Let $\boxed{R|R|R|R}$ represent a CA consisting entirely of reparables at its immediately lower indenture level.

*Except by pushing a button.

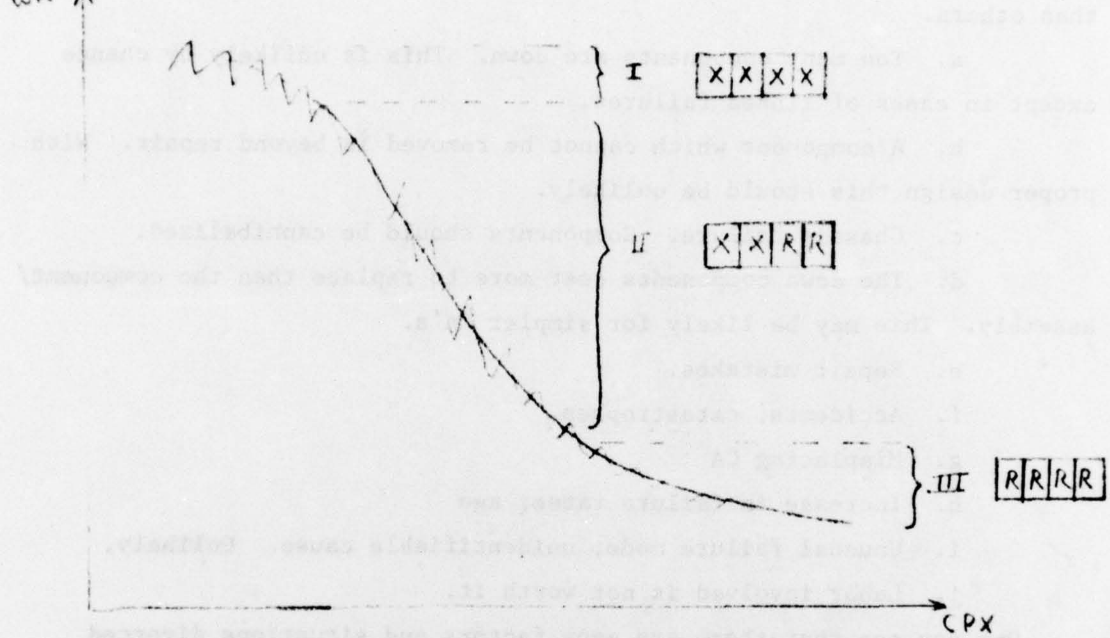


Figure 3.1 Washout Rate vs Assembly Complexity Measure

Region I consists of $\boxed{X|X|X|X}$ type CA's and there is some decrease in WR with complexity CPX. Region II has more dramatic decreases in WR as more and more reparables make up a CA. Finally Region III flattens out to some low WR for complex CA's comprised entirely of reparables which are pulled out and repaired rather than working on the CA as a whole. The overlayed curve depicts expected statistical fluctuations and also the possibility that the steep slope may very well be a staircase.

Assemblies could be grouped into families by some yet to be determined measure of complexity. The measure should distinguish to some degree the three types of CA's and associated regions. Subregions should be identified to obtain at least 10 families; these subregions may be defined by criteria other than complexity (see next page).

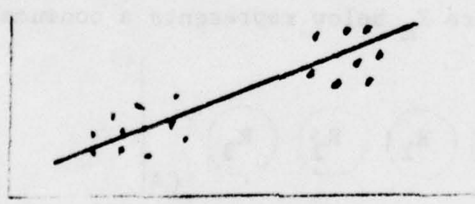
Regression and Cluster Analyses

These methods require a good deal of data points of washout

rates versus exogenous variables. The potential is there, since each reparable and each assembly of reparables within each fielded system can furnish observations over different periods of time. Clusters of WR values within different domains of a set of exogenous variables can yield initial estimates and confidence limits on WR. Possible exogenous variables:

a. Age
b. Average cost of components/cost of CA
c. Average repair time/cost of CA
d. Measures of complexity of CA
e. Cost of CA
f. Number of previous repairs
g. Measures of modularization
h. Measures of redundancy

A regression equation could also be determined for WR vs variables using the same data. I am wary of this overly quantitative procedure. For example, a least square linear fit thru two clusters is misleading.



3.3 <u>Block Analysis for Bounds on System Washout Rates</u>

This procedure can give ball park estimates on "system" washout rates. This is the rate deriving from rational economic decisions regarding system failures. Capricious, uneconomical, erroneous decisions and repair mistakes, accidents and losses add to the washout rates but are indirectly system oriented. As in Chapter II, we have an inductive procedure, in this case building upon washout rates for simple assemblies to obtain rates for more complex blocks of assemblies.

Suppose a CA is as below, with its component reparables R_i having washout rates w_i

Then it is reasonable, for rational economic reasons, that an upper bound on the WR of CA be given by

$$\text{u.b. } (w_{CA}) = \min (w_1, w_2, w_3) \text{ , e.g. } w_1$$

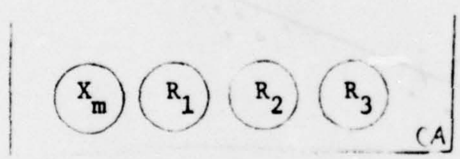
That is, if R_1 by itself has w_1, then in a more complex system CA, costing more, an upper bound on CA would be w_1.

Another heuristic relation on WR bounds is exemplified for multiple failures, e.g. if R_4 and R_5 fail together in 

$$\text{u.b. } (w_{CA}) = \max (w_4, w_5) \text{ , e.g. } w_5$$

The rationale here is that R_5 together with R_4 is a more costly assembly than R_5 alone, so w_{CA} cannot be higher than w_5. Also it is implied that R_4, R_5 failing together do not constitute a great increase in repair difficulty. In analyzing the impact of the $R_4 \circ R_5$ double failure in conjunction with other components, the bound value should be weighted by the probability of double failures.

For a situation where X_m below represents a consumable complex in CA,



develop a washout rate $w_m(X)$ for the complex alone considered as a reparable. Then

$$\text{u.b. } (w_{CA}) = \min (w_m(X), w_1, w_2, w_3)$$

<u>Elemental Analysis for Simple Assemblies of Consumables</u>

The inductive process above must be built upon washout rates for CA's of the type $\boxed{X \mid X \mid X \mid X}$. For a starting point, let's figure if 25% of the cost of CA fails in terms of components, it is economical to condemn CA. This supposes that (if CA is repaired for the first time),

replacements are double the cost of original parts, bringing the repair cost up to 50%; we also suppose that turn-around time increases 50% for multiple failures over its average for single failures, thereby implying a cost of "half" a CA, for a total cost of one CA. We do not consider single failures, because they have been analyzed in the original repair vs throw-away decision to make CA a reparable.

For example for CA consisting of 8 components, each having a failure probability of .01 and all 8 costing about the same, then 2 failures constitute 25% of the CA cost. Hence

Prob (2 failures/given there is a failure) = washout probability

$$= \frac{\binom{8}{2} (.01)^2 (.99)^6}{1 - (.99)^8} = .034$$

A washout rate of 3.4% is realistic. There is potential here for refining the approach extensively.

3.4 Updating Washout Rate Estimates

The updating procedure should be consistent with methods in [2] for updating maintenance factors and replacement rates per part for consumables. One must observe repair and replacement actions for a repairable at the depot level. From the maintenance and replacement task distribution one infers what the total repair and replacement rate (R+r) per part should be across all support levels. R+r is updated per the algorithms in Section 4.1 or 4.4.1 of [ ]. The replacement rate per part r is updated with the same type of algorithms. Then from the new estimates $\widehat{(R+r)}$ and $\hat{r}$, we form a new washout rate for the CA

$$\hat{w} = \frac{\hat{r}}{\widehat{(R+r)}} \qquad \text{(assumes all washouts eventually arrive at the depot)}$$

If a family concept has been implemented, this new rate will be stored in the CA's appropriate family file. As in [2], we recommend that stored estimates be combined with new technical estimates as

follows

$$\hat{w}(o) = \frac{Var(w_T)}{Var(w_T) + Var(w_F)} \cdot w_F + \frac{Var(w_F)}{Var(w_T) + Var(w_F)} \cdot w_T$$

where w_F = family estimate washout rate

w_T = technical estimate for new CA

$Var(\cdot)$ = variance of estimate

$\hat{w}(o)$ = initial estimate at time "o"

CHAPTER IV

RECOMMENDATIONS

In this chapter I briefly outline some recommended courses of action on aspects of the MTD, RTD and washout problems, based on the findings of this report.

a. Task Distributions - Initial Estimates

(1) Block Analysis - A general conceptual method is available; the degree of refinement is up to the user on an ad hoc basis since distributions are dependent upon the particular maintenance support environment. It is recommended that the DARCOM sponsor send this report under cover letter to at least two subordinate commands to review the appropriate sections.

(2) Family Concept - This method is not applicable due to the dependency of the task distributions on the particular system and support environment.

b. Task Distributions - Updating

It is difficult to extrapolate task distributions to future systems so updating is of limited use. The type of extensive data needed for analysis is available on a routine basis only for aircraft systems.

c. Washout Rates - Initial Estimates

(1) Block Analysis - Some ideas for a general concept have been discussed.

(2) Family Concept - Factors influencing the rate have been delineated. Regression and/or cluster analyses is recommended.

(1) and (2) should be investigated in a new IRO project.

d. Washout Rates - Updating

More work should be done to develop a technique which is consistent with the updating methods for replacement rates [ ] and which imposes at most the same data requirements. Investigate in same project as above.

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